Collected Abstracts of CSUMS MAA/AMS Conference Attendees

Enabling Physiologically Representative Simulations of Pancreatic Beta Cells

Sidafa Conde

Abstract

Within the endocrine system of the pancreas lie clusters of cells called the islets of Langerhans. Each islet is composed of four cell types, the most prevalent of which being the beta cell. We aim to continue the development of a computational islet and simulating the behavior of these cells. There exists a set of deterministic Ordinary Differential Equations (ODEs) that model insulin secretion within the beta cells. We consider cell dynamics on a cubic lattice of, on average, 1000 heterogeneous cells with key parameters including ionic fluxes, calcium handling, metabolism, and electrical coupling. By using sophisticated software, careful consideration of robust numerical methods, and effcient programming techniques, physiologically representative simulations of pancreatic beta cells become feasible. We provide an extensible, effcient, and functional computational islet simulator to aid research in beta cell dynamics. In particular, we adapt an existing dual electrical and glycolytic oscillator model into a numerically robust, modular set of Matlab files.

Numerical Modeling of Gravational Waves Accelerated by CUDA and OpenCL

Justin Mckennon

Abstract

Modern scientists in the field of astrophysics have become extremely fascinated by the study of Gravitational Waves (GWs) . These GWs were predicted by Einstein's theory of relativity but have never been directly observed. GWs (until recently) have been too weak to measure. GWs are of interest to the scientific community due to the information about the far reaches of the universe that they provide. The study and simulation of the sources of these waves has been greatly limited by the sheer mathematical complexity of the equations governing their behavior and evolution. Our work alleviates this issue by using the programming languages CUDA and OpenCL to accelerate these computations on the GPU.

Numerical Characterization of Quality of Compressive Sensing Matrix Generated through Different Random Methods

Charles Drake Poole

Abstract

Compressed sensing is a method of recovering interesting images from sparse sampling. To get an ideal reconstruction we want to recover as many entries of x as possible with as few as K measurements.(Emmanuel Candes) We want $\partial_{2S} + \theta_{S,2S} < 1$ to hold for large values of S, ideally of the order of K. By THM 3.1 and 3.2 in Compressive sampling. (Int. Congress of Mathematics, 3, pp. 1433-1452), they show that a trivial randomized matrix construction will obey the UUP for large values of S.

Using this knowledge of compressed sensing matrices we explore the phase space of possible sensing matrices completely for a small problem, seeing which matrix is quantitatively best. We then try to extrapolate those findings onto larger sensing matrices where the phase space is too large to fully computationally explore and attempt to show this method leads to a better sensing matrix than a fully random matrix. With prior knowledge of the images general interesting features, we then compare results with different methods of randomly populating the sensing matrix in accordance with our earlier extrapolation to show the numerical quality, or performance of the given method.

Finding Cliques

Leanne Silvia

Abstract

In a graph, a clique is a subset of vertices such that every two vertices are connected by an edge. We implement a novel algorithm, in Mathematica, to find all cliques in a simple graph. The run-time of this algorithm depends more on the maximum degree in a graph than on the total number of vertices. Up to a maximum degree of around 60 it appears to be faster at finding maximum cliques than the current algorithm in Combinatorica. It is important that the algorithm described finds all cliques and not just maximum cliques, since in some biological applications, such as protein-protein interactions, (see e.g. Sun & Gao, 2009) finding all cliques is biologically siginificant.

Methods of Fitting Geometry in Coordinate Metrology

Sumi Oldman

Abstract

Coordinate metrology is a branch of manufacturing science, where a coordinate measuring machine is used to measure the geometry and shape of an object. By obtaining coordinate data (X, Y, Z), reference geometry (such as lines, planes, circles, cylinders, cones, spheres) and least squares fit lines, dimension of distance, diameter, radii, etc. can be computed. The most important aspect of coordinate metrology is fitting reference geometry through an array of points so that the sum of the squares of the distance from those points to the line is minimized. Using computational methods, values of x are selected to minimize $||b - Ax||^2$. Experiments using different fitting methods will increase the possibilities of computing distances of least squares lines to points more efficiently.

A Hybrid RBF/Fourier Method for Correcting Fourier Co-efficients from Irregular Wavelengths

Zack Grant

Abstract

Fourier Series approximations are well known for their spectral convergence of data reconstructions on smooth and periodic functions. Common practice when one gathers information for these function approximations is to collect them on integer π wavelengths in Fourier Space. However when collecting our data on frequencies that are not on these ideal wavelengths the approximations fail to achieve high accuracy.This problem is relevant due to methods in collecting data by MRI machines where collection is solely through Fourier waves; but not always on ideal wavelengths. Our work tries to minimize the errors caused through these irregular wavelengths by using Radial Basis Functions to correct our coefficients. We show this method minimizes error caused by irregular wavelengths on common problems.